SCIENCE

VOL. LXXII FRIDAY, OCTOBER 31, 1930 No. 1870

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

POLAR EXPLORATION[1]

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IT was but yesterday in the procession of "the eternal years" that men sought knowledge of the higher will by consulting the oracle, the shrine where the voice could be heard that told what to do and what would happen. "There mighty Nations shall inquire their doom," and there the individual, if powerful enough, might even hope "to work the oracle" and bring private wish and future event into harmony. What men were striving after was fore-knowledge of the event, forecast, or, in another connotation and using the modern term of a scientist of the Indian Meteorological Department, "foreshadowing." It is rather striking that this early manifestation of human curiosity is reflected in the scientific era. Within the scope of its "laws," or, better said, its generalizations, science to-day sets up forecast as one of its highest aims. *Omitting California,* the most common question of civilization is, "What will the weather be to-day?" and, as Mark Jefferson has phrased it, if the forecaster can not tell us whether or not it will rain at least we wish him to tell us if it is prudent to carry an umbrella. In a state so well supplied with observatories and in the presence of such eminent astronomers I do not wish to draw upon even that nearer heaven, the sky, for further illustrations of forecast, but you will perhaps permit me to mention the tides and the celebrated tide machine of the U. S. Coast and Geodetic Survey that permits an operator to pull levers and scan indices and, at length, by what to the layman seems mystery as deep as an oracle, derive the future time of occurrence of the tide at a given point on the earth with all but mathematical accuracy!

It happens that polar exploration has participated in this advance from the place of wish-and-guess to the eye-piece of an instrument of precision and a knowledge of the workings of natural laws, and I have

[1] Public address under the auspices of the National Academy of Sciences given at the University of California on the evening of September 18, 1930.

been asked to outline its part in terms of modern science. Let me say at once that there was no thought of forecast in the beginnings of polar exploration. On the contrary, so far as the record permits us to learn, we see at first no other force in men's minds than that driving curiosity which is the motive power of most exploration everywhere and which impelled Pytheas of Massilia to the shores of Britain as it in like manner took Nansen to the inner Arctic where the secret of one part of the oceanographic puzzle might be found. Man insists on knowing what is in the outer world—the world outside the boundary posts of knowledge. Once it was discovered that such knowledge had utilitarian value, economics took a permanent place beside curiosity. "Scoresby Sound" in Eastern Greenland records a happy blend of business and curiosity on the part of that knight errant of Arctic exploration, Captain William Scoresby, who in thirty voyages to Greenland brought back rich cargoes of whale oil and even more valuable cargoes of geographical information from "a coast that was almost entirely unknown."

Exploration from earliest times to quite recent years began and ended in description of which the map was a kind of shorthand. Apart from adventure, the map told the story of what had been found: it enabled one to look at distant places "as if they were on the palm of your hand," to use the inscription employed in a Chinese atlas. To fill in the map has been one of the leading ambitions of explorers and will so remain until the last of earth's territory has been seen either by the eye or the camera, for if an electrically guided airplane and automatic camera should ever become feasible we may some day be able to map lands that no eye will have seen. When science had moved ahead to its modern position, exploration became a far richer enterprise. To-day it may be as varied as science itself. I remember receiving an inquiry from Professor Millikan for a lake in the Central Andes at the highest altitude which it was practicable to reach and of given size and depth, and fed principally by melting snow. So much of geographical requirement was laid down for the study of cosmic rays. The German Greenland Expedition has already experimented in ice-thickness measurements by echo soundings with an improved seismic device. Wilkins plans next year to explore the Arctic by submarine, his program including gravity determinations at sea and aerological work from the ice. Lars Christensen plans to have his captains make a census of Antarctic whales by airplane, the counting to be done from aloft in a single season possibly by the cooperation of several ships, each to take a sector of the waters off the south-polar continent if it should prove impossible for one vessel to make the circumnavigation.

It is natural in the face of all of these diversities of purpose, this extension of technology on a great scale to high latitudes, that the key to special types of forecast should also be sought in the polar regions. Man has learned that within certain narrow limits he can forecast a widening range of events in the physical world, and he finds that his new knowledge permits him to develop to increasing degree a more satisfactory "philosophy of the whole." It measurably satisfies man and it engrosses his interest to discover that there is an orderly scheme of things and that some of the workings and even the forecasts of such workings can become known to him. We are not surprised over the controversies of an earlier generation, and so recently even in our own, over questions of science and faith when we discover how lately science began to outline the physical universe and gain the power to forecast the effects of a few of the forces that are governed by law. It was not until just before the Revolutionary War that Franklin charted the approximate course of the Gulf Stream, and it was Franklin also who first traced the progress of cyclones. Ferell's law of behavior of the air in a cyclone was enunciated much less than a hundred years ago. The first self-recording instrument was taken into the Arctic (Parry) only a little more than a hundred years ago. The "polar front" or "squall line" theory with its important bearings upon the paths and character of cyclones, especially between Greenland and Norway, was outlined by Bjerknes only a few years ago.

There still remain in the world unexplored lands of total area at least twice that of the United States. The "Empty Quarter" of Arabia, lying almost within sight of the oldest routes of migration and trade in the world, measures 500 miles by 800 miles, and is therefore nearly a half million square miles in extent. So far as we can learn, no Western explorer has ever entered it. Though we weigh the stars and plot the courses of unseen planets we are yet without knowledge of much of the immediate world of mankind itself. We still live in the Age of Discovery, at whose threshold stood Herodotus and Prince Henry the Navigator and Eric the Red and Columbus. Indeed, if the men who made the Age of Discovery were to compare their lot with those of to-day they would vigorously assert that we, not they, live full within that age, for they would see an airplane flying upside down, human voices talking across ten thousand miles of space, an airship hitchhiking on the tail of a storm (*e.g.*, Eckener between the Sea of Okhotsk and Tokyo in his flight of August, 1929). However old the world may seem when judged by the record of the rocks, it is in an intellectual and

exploratory sense tremendously new—it is indeed as new as its newest idea!

The new ideas in polar exploration are not airplane and radio—these are but instruments of discovery. They are astonishingly reliable and useful instruments but they are of mechanical interest only, apart from the ideas they serve. Science feared for a time that they would run away with the game, because the popular mind is still on the romance of flying and the magic of communication by wireless. The really big game of the polar hunt are the scientific ideas or laws upon which the polar regions, and in some cases they alone, can throw light. Science is searching for particular things, not just anything. Real exploration has ceased to be a blind and adventurous wandering into the unknown. Take the contrast in present-day life and fossil remains at the two ends of the earth. The ring of land about the Arctic Basin has a mean summer temperature above freezing and the ground may thaw a few inches in a very few days. There are over four hundred flowering plants, some of them luxuriant. Past land connections have been sufficiently short and frequent to permit life migrations from continent to continent at least in the subarctic zone, with the result that it is possible to reach rather definite conclusions about the lands and seas of the past in the northern hemisphere and how things came to be as they are. No such definite conclusions can yet be drawn for the Antarctic. That region is still so great a mystery that were a fossil marsupial to be discovered there the event would excite some scientists probably as much as direct radio communication with Mars. I have mentioned marsupials because of the apparent need for a land bridge across Antarctica to account for certain similarities of structure between those of Patagonia and those of distant Australia.

Professor Scott is of the opinion that the most probable explanation of the origin of Australian marsupials is that a land connection existed at one time "by way of the Antarctic continent," a land connection that existed in early Tertiary times and by means of which the ancestors of the Australian marsupials migrated from South America. Others suggest that a point of origin in the Antarctic with migration on the one hand into Patagonia and on the other into Australia may be found to satisfy the facts of the case. In opposition is Matthew, who believes that the marsupials of these southern land masses were derived from northern ancestors. He relies upon parallel adaptations to explain the absence of a really close affinity between the forms under consideration. Anderson, on evidence more recent than that employed by Matthew, finds closer affinities between Australian and Patagonian forms than were known hitherto. However, he points to the conflict of evidence derived from a study of frogs, mollusca and plants. There is no positive evidence of the presence of marsupials in Australia before the Pliocene, and there is even an astonishing "paucity of pre-Pleistocene marsupial remains" in Australia. One of the major problems of animal migration is still in the stage of hypothesis for want of critical evidence that Antarctica may yet supply.

It is the meagerness of Antarctic life that makes wide-ranging speculation concerning the past history of Antarctica so difficult. There are but two flowering plants in the Antarctic, and these have a precarious hold at the extreme limit of their range. One is a grass; the other represents a family of herbs. Both are dwarfed. There are only the tiniest patches of tundra. No month has a mean temperature above freezing and the summers last but a few weeks. The search for fossils in Antarctica is to-day keener than ever because not only past but present distributions of life seem to find their explanation through them. In addition the search has already revealed that the life of Antarctica was once far more abundant. In the Jurassic period the whole earth enjoyed a climate milder than that of to-day. At that time there lived in West Antarctica the Sequoia, the Araucaria and the beech. With life so much scantier to-day we can see why Professor Gould, of Admiral Byrd's expedition, attached so much importance to the *earlier* record, however scantily revealed, in the carbonaceous sandstones from Mt. Fridtjof Nansen. Even the contents of the stomachs of seals and penguins have been searched for rock specimens, and thus much valuable information has been found about coastlines where no exposed rock exists. The dredge has brought up from the bottom of the Weddell Sea, from a depth of 10,000 feet, fragments of coral rock of Cambrian age; and the ice tongues that pour out through the western mountain passageways of the Ross Sea depression have borne from distant points limestone fragments of the same age that throw light upon past conditions. Mawson has just found that the erratics on the sea floor off Enderby Land are all continental in type, thus pointing to the unity of the new territory he has added to the map with the continental mass of Antarctica between Enderby Land and the Ross Sea. The fact is of special significance in tracing past life migrations and in building up sound concepts of life habitats.

It is the higher forms of life, however, that interest us most, for here we are closer to the background of man himself. Where we now have a highly specialized group of birds of which three are exclusively Antarctic species (the skua, the Adélie penguin and the emperor penguin) there was once a greater

variety. If we include fossil penguins of wider range the number of extinct species already known rises to twelve. It has been suggested that the diminished number of species and their higher specialization to-day were brought about by the advancing ice in a period of glaciation (not necessarily a colder period) even more extensive than the present one, for the ice at the present time has withdrawn from the wider limits it once claimed. If Antarctica to-day seems almost buried in ice, we can only say that in a still earlier period it was *overwhelmed.*

Among the leading objectives of all polar explorers of the past one hundred years are meteorological observations. In ever-increasing degree the polar explorer is besought by science to obtain exact records in increasing number in high latitudes. Less attention was paid to this feature of exploration in earlier years because the dynamics of the atmosphere were until recently so little known. Though Franklin had discovered the most significant feature of temperate-zone weather, it was many years before Ferell expressed the matter in dynamic terms. The first polar explorers could go only so far as the state of technology and theory permitted. The science of meteorology is a quite recent development. "Weather probabilities" were issued by Abbe at Cincinnati for the first time in 1869, and the first official weather forecasts were those of November and December, 1870. The word "probabilities" was displaced by "indications" in 1876, and the term "forecast" was adopted in April, 1889, only forty-one years ago.

The part that the polar regions had to play in the terrestrial wind system was only hinted at by the earliest observations, and theory took little account of the influence of great shifts of air from out of the polar regions to lower latitudes. In 1882–83 for the first time there was established through the work of the International Polar Conferences of Hamburg, Berne and St. Petersburg a chain of meteorological stations with the object of comparing simultaneous records at widely separated points. Eleven nations participated. Fourteen stations were occupied, three in the southern hemisphere. Following the first International Polar Year by an interval of two decades there were sent out a number of Antarctic expeditions in pursuance of plans discussed in outline at the International Geographical Congresses of London (1895) and Berlin (1899). Scott's first expedition represented the British, Bruce led the Scottish expedition, Nordenskold the Swedish, Drygalski the German and Charcot the French. The period 1901 to 1904 includes them all. A Belgian expedition had taken the field in 1898–99, and Charcot's second expedition operated in the period 1908 to 1910. These were animated, some in part only, others chiefly, by a desire to make comparable weather records at widely separated points about the border of the Antarctic.

The United States expedition to Lady Franklin Bay under the command of Lieutenant (now General) Greely, and an expedition to Point Barrow, Alaska, were the principal contributions of the United States to the first great international undertaking in the Arctic. Though more than a score of volumes have been published upon it, some of the results are still not completely worked up. It is argued by Henry that the first International Polar Year was held fifty years too soon. "There was left a gap between the polar stations and those of the middle latitudes entirely too wide to span by any sort of interpolation and thus the relation of polar weather to the weather of mid-latitudes failed of discovery." The daily weather charts constructed on the basis of the 1882–83 observations for a thirteen-month period revealed "a state of turmoil," as Sir Napier Shaw has expressed it, that "defies simplicity of description," and the formulation of laws of behavior of storms in the North Atlantic had to be deferred. The progress of cyclones and anticyclones across the Atlantic as revealed by these earlier studies was of little value in forecasting for western Europe.

But meteorological stations have been established in much greater numbers and much farther north in the interval of fifty years since the First International Polar Year. With the object of carrying out a more extensive program of observations (of possible value in future efforts to discover correlations between high and low latitude climatic conditions), there has been devised a program for a Second International Polar Year, 1932–33. An international committee of meteorological directors has taken the initiative in planning the position of stations and the precise nature of the observations on terrestrial magnetism, atmospheric electricity and meteorology, the observations to be carried through according to carefully devised techniques. In support of this proposal the American Geophysical Union has strongly endorsed the proposal that the United States government take a part in the establishment of certain stations and that the cooperation of private research organizations be solicited. Thus the National Research Council and the National Academy of Sciences will participate in what is believed will be one of the major scientific undertakings of the next few years.

The work of the Second International Polar Year and the meteorological observations of Arctic and Antarctic explorers in recent years are both inspired by a profound curiosity as to the suspected influence of weather conditions in high latitudes upon (or interaction with) those of the temperate regions as well as the tropics. The atmosphere is governed by phys-

ical laws and it is sought to discover the workings of those laws. We are here dealing with some of the greatest of the natural forces of the earth. To appreciate the magnitudes involved take the figures given by Shaw. He calculates that, subject to a correction of not more than 5 per cent. for air displaced by mountains, the mass of air in the northern hemisphere exceeds its mean value by over five billion tons in the month of January and falls short of its mean value by over five billion tons in July. This great shift of ten billion tons of air from hemisphere to hemisphere (timed to follow the curve of total power of solar radiation by twenty-seven days) is the equivalent of a mass of air thirty miles wide extending quite around the earth. So great a migration of air is not accomplished in a single simple movement, diagrammatically clear, mathematically precise, from point to point. There are many local variations, and there are also variations in time that appear when the figure is analyzed in detail.

Region by region it is the variations in the broad effects that are of concern to science seeking to learn the exact processes through which weather changes come about. Even the local or regional atmospheric displacements are represented by extraordinary magnitudes. The total energy of the motion of the winds of the earth has been calculated at "something near 20 billion horse-power-hours." Here we deal with figures that are akin to those of the astronomer, who deals with space, and the more we come to know of the atmosphere the larger the figures seem to become —in which respect at least we are gaining on the astronomer who, according to one of their high priests at a recent meeting of the American Astronomical Society, concluded that the astronomer must give up some of the territory over which he had extended claims of imperialistic magnitude!

A calculation of the forces involved in a single localized low-pressure area prepares one to believe that the polar regions include centers of action of astounding size and of direct interest and practical importance to mankind in the temperate zones. When the world was but thinly populated and wide spaces of excellent arable land awaited the settler we could afford to have little concern about the weather machine in its remoter manifestations of power. We see that in the historical development of our weather services. The Meteorological Office of Great Britain was established in 1854 "for the sea and navigation, not for the land and agriculture," and at its head was an admiral. The concern of Great Britain for meteorology grew out of the need for more precise information in making forecasts of value to ships and shipping. Our own weather service had its beginning in the United States Army in 1870. It was established primarily to serve agricultural interests. With the development of immense horticultural interests in the United States the need for precise forecasts has grown correspondingly. Plants that can not stand frost are grown up to the extreme limit of their range, the farmer demanding that science keep pace with him not merely in the selection of soil and seed but also in foretelling the weather.

Since the World War there has been a vast extension of settlement on the pioneer fringe of the habitable lands. Many thousands have gone into northern Canada, extending the edge of the plowed land far northward along a belt hundreds of miles in extent from the Rocky Mountains southeastward to the Laurentian Highland. In the past twenty-five years fifteen million Chinese have gone into Manchuria and hundreds of thousands of settlers are carrying the plow into the moister southeastern border of Mongolia. Pioneer development is in full swing in Southern and Northern Rhodesia and other parts of southern Africa. Australia has an immense territory of sun-baked land in which the marginal conditions of climate and settlement are maintained in delicate balance. We need not inquire at this time as to whether this immense thrust of modern civilization into land hitherto unoccupied is justified by an existing need of the world for additional food supplies. Despite the contention that in our machine age we do not need additional acreages of arable land, millions of settlers are still crowding the frontier. The pressure is not for more land but for cheap land that can not be found in the highly capitalized and overtaxed older communities. So long as people advance into the pioneer belts just so long must applied science follow them and attempt to ameliorate marginal conditions of living.

It is here that forecast should play a dominating rôle. Man does not ask the earth to be kinder to him; he asks only to be informed of its intentions that he may at least prepare for or deflect the effects of those great forces which he can not hope to neutralize or destroy. It happens that some of the pioneer land that remains in the world is on the poleward border of the so-called temperate zones, especially those of Canada, Siberia and Manchuria. Whatever connection may be found between polar or at least subpolar climates and those of the temperate zones will probably be of most direct benefit to the populations of the remaining pioneer lands which are still of great aggregate extent.

Once we knew the habit of the "spells" of Antarctic border weather we should be able to trace the connection, if such exists, between them and the rainy and dry periods in the cereal and pastoral lands of Australia, South Africa and Argentina. It is under

the impulse of this idea that Captain Sir Hubert Wilkins has carried on his explorations in the Antarctic Archipelago for two seasons. He did not go down there just for fun; he has been searching for suitable bases for meteorological stations to be established by international cooperation. With a ring of such stations about the Antarctic, and with daily weather reports from them by radio, it may be possible to draw charts that trace the effects of cyclones and anticyclones as they move forward from breeding places out over the southern ocean. The problem is in no sense one that will be solved in a simple manner. Correlation is the basis of forecast and the laws of correlation can only be developed after an observational basis has been established.

To forecast seasons of drought in the lands of the southern hemisphere would be a practical achievement of the highest order, and no less important would it be to forecast seasons of exceptional rain. We have in Australia, Argentina and South Africa great areas of marginal lands where for several years on end it may be too dry to maintain flocks and herds and crops of normal extent. Even in years of sufficient rain the farmer needs notice of the event to enable him to take advantage of nature's bounty. It is not putting the case too strongly to say that the practical benefits to southern lands of meteorological studies in the Antarctic through the medium of a chain of weather stations outweigh all other Antarctic interests, of a material sort, put together.

Through a series of field expeditions in Greenland, Professor W. H. Hobbs has confirmed the theory of slope effect and revealed Greenland as one of the important centers of action in the Arctic on a scale smaller than similar centers in the Antarctic but quite as important in effect for large portions of northwestern Europe. Combining the flight observations of Captain Sir Hubert Wilkins and those of the Norwegian weather charts, Sir Napier Shaw has traced the march of a "cold front" from Greenland to the Norwegian coast from April 14 to 16, 1928, and has outlined the dynamics of the process of the flowage of air from Greenland "to take part in the formation of snow and rain about Spitsbergen." Southern Greenland, like the Aleutian Islands, appears to be a special center of conflict between polar and equatorial air and therefore among the most critical localities on the border of the Arctic region for the study of interchanges between these two great climatic belts.

The former director of the Dominion Meteorological Service of Canada, Sir Frederic Stupart (and others), has pointed to a persistent stream of low-pressure areas approaching the northeastern coasts of Canada and Alaska from the Pacific and passing into and perhaps across the continent of North America, while another stream passes from the Gulf of St. Lawrence eastward past southern Greenland and northwestern Scandinavia, with the polar regions lying between these two great streams. He points to the variations in atmospheric circulation caused by the difference in habit from season to season of the cyclonic areas that form in the Pacific and which move into America sometimes abnormally far toward the north, sometimes abnormally far toward the south. Science can not yet state either the dynamics of the case or the causes that lie back of these major changes, but it seeks light on the question in both high and low latitudes. It is not content with its present position in the matter. Its object is forecast as well as explanation. The two are the right and left hands of the argument. To see so far and yet not see farther, to know so many things about the atmosphere and yet be unable to forecast the major changes that produce profound effects upon the climate of inhabited regions—these are the things that challenge the ingenuity of the physical scientist and that inspire his curiosity as to the exact conditions to be found across the threshold of the Arctic.

Playing a part in the great meteorological set-up of the world is the habit of the ice both north and south. Krümmel estimates the volume of the drift ice which reaches the Atlantic Ocean yearly from the North Polar region at 20,000 cubic kilometers. An estimate of 30,000 cubic kilometers has been made for the Antarctic, or 50,000 cubic kilometers in all. This represents a column of ice with a base larger than twelve city blocks (1,400,000 square feet) and reaching out into space as far as the moon. If evenly distributed it would cover the entire land surface of the earth with a layer of ice a foot thick! These are of the first order of geographical magnitudes and their mere statement is enough to show why significance is attached to the meteorological relations of polar ice discharge. But this is not all. The ice discharge is subject to very great variations from year to year. Commander Smith reported about 1,200 icebergs south of Newfoundland in 1912, while in 1924 the total was only eleven! Taylor has described Antarctica as "a fluctuating refrigerator" on a colossal scale. In calmer periods ice gathers; in stormy periods it dissipates with wide effects because low-pressure areas "whose northern portions" bring precious winter rains to the nearest tips of the southern continents "move mostly over far southern waters."

The English meteorologist, Brooks, has made a statistical investigation of the influence of the Arctic ice on the pressure distribution of western Europe. From a study of ice conditions in spring and summer in a part of the Arctic made known to us from annual

surveys of ice conditions by the Danish Meteorological Institute it has been sought to discover relationships between the quantity and the position of the ice and the pressure of the atmosphere at selected stations in Greenland, Norway and elsewhere. It has been found that when there is much ice in the Arctic definite increases of atmospheric pressure may be discerned in spring and summer at some stations and a diminished pressure at others. The pressure of the late autumn and winter is below normal over the British Isles and northern France when there is much ice in the Arctic. Similar effects tend to recur annually at northern stations for about three years following abnormal ice years. It must not be supposed from this statement of relationships that the matter is quite as simple as the phraseology would suggest. It has been found that the influence varies with the season and thus appears to be due to a combination of several factors, some acting in one direction, some in another. The "correlation coefficients," as the scientist calls them, are never high, but they are regarded by Brooks as being appreciable at times, and he concludes that they represent realities. Some of the Arctic ice correlations are more immediately useful. Commander Smith, of the International Ice Patrol, has described a method of ice forecasting that has been employed with "a high degree of success."

Certain ice and weather correlations were noted many years ago and again more recently by Dr. Otto Pettersson. Between 1892 and 1897 there was "an enormous outburst of ice from the Antarctic which filled the Southern Ocean with ice floes and icebergs to such an extent that traffic between South America, Africa and Australia had to seek a more northerly track." In Pettersson's view this outburst had far-reaching climatic repercussions. The monsoon region of the Indian Ocean was profoundly disturbed. Years of excessive rainfall (1893 and 1894) were succeeded by years of drought (1896 and 1899) followed by wide-spread famine. The loss of cattle ran into the millions. Australia also suffered. In New South Wales and Queensland almost continuous drought prevailed from 1896 to 1902. In these seven years it is estimated that there were lost over fifty million sheep at a value of over sixty million dollars. Ice dangerous to navigation was again reported in relatively low southern latitudes in 1922. The Humboldt Current was deflected westward early in 1925, and warm coastal waters running southward between the Humboldt Current and the Peruvian Coast brought an abnormal rainfall along the arid western border of Ecuador, Peru and Chile, with destructive effects upon plantations and houses, irrigation canals and ports and towns unaccustomed to the rain which comes only at intervals of several or many years. Whatever the relationships between the argument and the observational basis of Pettersson, it can hardly be supposed that the changes that take place on so colossal a scale in the movement of ice out of the Arctic Sea and off the Antarctic Continent and northward from surrounding waters are without their climatic effects.

Commander Smith, of the Ice Patrol, has found bottom water in the trough between Greenland and Labrador of such low temperature (2.6° C.) and high salinity (34.90) as to point to an Antarctic origin, which means a slow creep northward over the intervening 10,000 miles of distance. But until the scattered reports of ice conditions, current flow and climatic changes (now gathered largely at haphazard) are brought into some systematic relation, or, better still, until sustained and cooperative observation has taken the place of scattered and uncontrolled observation, we shall be without that specific information upon which alone can be based an outline of the dynamic relation between the ice discharges of high latitudes and the climates of the poleward margin of the northern and southern temperate zones. The study of the ice on the one hand and of the habits of the migratory high and low pressure areas on the other are two of the major interests of science in polar exploration to-day.

We can not hope that long-range weather forecasts will do more than show the direction which a predicted change will take, that is, that the year or years ahead will *tend* to be drier or wetter as measured by an average year. One has only to see Biel's recent world map showing the variability of the annual rainfall from region to region to observe that prediction can not be based upon a single sweeping law. So far as we can see at the present time it is only by the patient fitting together of at least the critical parts of existing records and those yet to be gathered in selected places that a substantial basis of forecast may be found. The variability of rainfall expressed on Biel's map runs from less than 10 to more than 40 per cent., and the zones of given variabilities are in general of most irregular pattern. It is significant that the only seasonal forecasts now attempted by government are in tropical regions where the meteorological conditions are fairly constant as compared with those of higher latitudes. They are the forecasts for India made by the Indian Meteorological Department, and those for Java made at the Batavia observatory. This lends added interest to meteorological studies in the polar regions, since one may hazard the guess that whatever basis of forecast may be found practicable in the tropics and temperate zones the forecasts for the higher latitudes of northern North America and northern Europe as well as those of South Africa and Argentina will be found to depend upon conditions

that are at least influenced by what happens in polar centers of action.

This is getting a long way from the empirical studies (useful as they have been) that marked the first steps in the direction of forecast. It is also a quite different thing from the deductions and partial correlations based on a study of astronomical cycles or upon the simple supposition that because the climatic changes of the past have had a certain recognizable periodicity such periodicities will be repeated more or less regularly in the future.

One can hardly appreciate the value which the scientist attaches to meteorological observations in the polar regions if he supposes that physical science advances by precise laboratory methods alone. At the present time some of the leaders in the social sciences are striving to discover something akin to the precise techniques and exact measurements of the physical sciences in order that human behavior may be "scientifically" studied. There is danger that such a point of view may overlook a difficulty of the physical sciences that is clouded by the striking fact that it has so many precise results. I refer to "field relations." One may experiment with air in a laboratory or with a crystal or with an electric current or with a lens and obtain certain precise values. But in many if not in most cases this is not the object of the scientist who conducts the experiment. His ultimate objective is not merely the thing before him but the law involved; and once he has discovered the law he attempts to apply it to the field. Here is where he is confronted with quite special difficulties because the field is almost infinitely complex if he deals with anything more than broad generalities. To a large degree "the wind bloweth where it listeth," in spite of the laws of dynamic meteorology. There is a topography to be taken into account and a host of complicating conditions of land and sea and ice, earth's rotation and water vapor and changes in solar radiation.

To the complications of nature are added those of observation and record and the assembly of an infinity of figures. The meteorologist is obliged to use observations "which can never be repeated and which have been made by some one else" (Shaw). In forecast it is still true that no dependable sequence of events has been worked out except locally, as in India and Java. To this number should be added the rainfall predictions of the Scripps Institution of Oceanography, which by a study of the temperature of the adjacent sea has been able to predict the rainfall of parts of the Southwest (U. S.) "with encouraging accuracy" (nine successful forecasts in twelve years). There are suggestions of other correlations, as, for instance, those of Commander Smith, who seems to find in the recent temporary amelioration of Arctic climate some relation to what he calls a "heat reservoir of tremendous proportions," namely, a surface layer in the North Atlantic over 300 feet in thickness covering an ocean area 100,000 square miles in extent and showing a temperature five degrees higher than normal.

There are many events for which we need no forecast if we once know what the facts really are. We happen to know accurately enough the history of the Nile floods for 960 years, and we know that only four times in that millennium has the river been as low as it was in 1913–14. Merely to know that fact is to know of the negligibly small chance of an extremely low Nile within a limited period of years in the immediate future. Facts and more facts of this character are what has given man his mastery over the earth to a large degree—he has seized facts and at least here and there directed his destiny to a desired end. If we are ever accurately to state the events that precede, accompany and follow important changes in ocean currents, as, for example, off the Peruvian coast in 1925, we shall have to make studies of far wider scope and seek correlations of which at the present time we have in most cases no hint.

Once we have carried our thinking to this point we see the great importance of an expedition like that which Captain Sir Hubert Wilkins and Lincoln Ellsworth are proposing to take into the Arctic in the summer of 1931. On a route 2,200 miles long from Spitsbergen to Alaska they propose to make life studies, take gravity measurements, secure bottom samples, observe the conditions of terrestrial magnetism and study the currents, the ice and especially the temperature and salinity of the sea water, as well as take soundings by the echo depth sounding device and wherever possible send up balloons equipped with meteorological instruments that will reveal the condition of the upper air. That these studies are to be made in a submarine seems at first wholly fantastic. But no one who has studied the plans in detail can fail to be impressed with the practicability of the scheme, for it is based upon a thorough knowledge, on the part of the leaders, of ice conditions across the entire Arctic Basin. Captain Wilkins's flight of April, 1928, equipped him to study the surface ice from the standpoint of submarine navigation, and along a different path Ellsworth was able to observe the character of summer ice.

The layman might suppose from the definite conclusions which science has reached here and there or from the definite objectives which it sets up in every field that we should presently come to the end of things. Here and there one hears the phrase "when science has gone as far as it can" or "when we have learned all that there is to know." If such were indeed the case we should need to be in no hurry

about the attainment of the end. Polar exploration, like all other forms of exploration or of creative thinking, could well afford to take its time. We might even go so far as to consider the suggestion that has come to us from the social sciences (none too seriously made, of course) that there should be declared a moratorium in the physical sciences. As a matter of fact, science can not be restricted by quotas. We can never declare a moratorium on curiosity. We can never know too much about this amazing universe unless we are to suppose that ultimate knowledge is evil. All that science has done up to the present is to provide glimpses into what we call the natural world. Each advance supplies a fresh incentive for further research. Each discovery is a springboard from which another jump is made into the unknown. Recently the head of an American institution announced that there had been "solved the problem of the Southwest." Apart from the fact that there is no one problem of the Southwest, the "Southwest" is hardly a thing to be solved! In making a proposal for a given study its sponsor remarked to me recently, "Let's get this thing settled once for all." He was dealing with a matter involving such variables as winds and ocean currents and the migrations of people of whom we have but the most fragmentary records.

The scientist does not seek the end of things in the sense of these two quotations. He is trying to discern the process, to discover the law. He does not say, "Here we are at last!" but "Where next?" This is the real spirit of discovery. It is true that we are able to express magnitudes so great that formulas have to be devised if the figures are not to escape human comprehension. It is true that we have girdled the earth with human speech, provided a partial post-glacial chronology accurate almost to within a year, and measured the depths of the sea with a sound wave. But it is also true that we have not yet discovered a way to stop the scourge of cancer, that we have not provided mankind with a reliable long-range forecast of the weather however much we may know of the physics of the air, nor have we been able to put the vagrant energies of tides and winds to the service of the steadier purposes of mankind.

We have not been able to do these things and many others because the statesmanship of science is not equal to the task of developing the techniques of science fast enough to keep pace with our needs, or if techniques are developed we are not able to discern as rapidly as we should the wider unities without which technology has no meaning. From an enormous mass of facts science must comb out the accidental and discover that which has significance, that which is recurrent, that which seems to relate cause and effect. Polar exploration is no exception to this rule. The literature of the subject is filled with romance and adventure, with casual happenings. Thousands of pages are filled with wholly irrelevant details, from the scientific standpoint. Those who work upon the creative fringe of the sciences that are served by polar exploration must read far to find a little. Partly this is due to the fact that youth and leadership are required to face the hard conditions of Arctic and Antarctic living. The first essential, before the maturities of science are given a chance, is to get in and out safely or at least with reasonable chance of security. Hard work and great risks are the rule. This means that we can not put romance out of the business. We like to personalize expeditions and events, to build up a hero. The heavy financial requirements can be met apparently only through agencies that demand news, and polar news is largely polar adventure. Nor is it adventure to the layman only. The scientist himself is conscious of the unknown about him. And who can escape the sense of mystery that pervades the unknown? Under such circumstances one can not wish to set metes and bounds to the imagination.

There is a wider sense in which we need exploration of the ends of the earth and why curiosity drives men into the unknown places. From the philosophy with which science was at first closely associated it long inherited the concept of "system," and the need for text-books tended to cause still further devotion to system. The creative fringe of scientific thought is often lost sight of in the too rigid formulation of law. Men have escaped the pain of thinking by inventing words that defeat the spirit of curiosity. To take a familiar example, we have in science the word "anomaly." If a thing does not fit into the regularities of the accepted system it is labeled "abnormal" or at least "anomalous." So far as the earth sciences are concerned I should say that it is a distinctive feature of their development in the last twenty-five years that inquiry is largely directed to the investigation of the anomalous occurrence, for is not the anomalous occurrence itself obedient to law? The lexicographer defines the word *anomalous* as "exceptional" or "unusual." When he goes on to term it "irregular" we do not follow him. When the Humboldt Current is displaced by the warm water creeping out of the Gulf of Guayaquil and down the coast of Peru at intervals of years we look upon this commonly well-behaved stream as exhibiting an anomalous course and the popular mind regards the occurrence as freakish. But science concentrates upon the anomalous behavior of the Humboldt Current and sees that the unusual behavior of that stream has a certain regularity if not perhaps a periodicity. We have hints that its deflection is an annual occurrence and what we have

termed "anomalous" in it becomes only an expression of degree. From many such occurrences the scientist takes a fresh view of his world of nature and at last begins to wonder whether the anomalies of that nature are not of more critical importance than the generalized systems that include only so-called "normal" occurrences.

We are all aware that the physical processes that control our weather are not uniform in their behavior. Aside from the purely accidental there are certain long-range changes in meteorological conditions. From time to time we are brought to a full realization of a long-range increase or decrease of rainfall by their calamitous effects—the starvation of millions in Russia and India or the disastrous losses in the live stock industry in South Africa and Australia. The drought in the United States during this past summer startles us into a realization that nature now and then seems to defy its own mode.

In the search for the causes of these unusual or anomalous changes the widest comparisons have been made of climatic conditions in different parts of the world. The records of thousands of stations have been scrutinized. In the United States a preliminary examination of the records shows that "the occurrence of wet and dry years seems to be wholly fortuitous." The most we can say is that there appears to be a general tendency toward years of lean rainfall, with years of greater rainfall making their appearance only when there is "an extraordinary disturbance in one or more of the dominant members of the atmospheric circulation" (Henry). Different parts of the country seem to have their return of wet or dry years with great variation, so that the probability of heavy rains becomes less the greater the area involved. This is a most striking conclusion for a territory so large as the United States, but its significance seems to be diminished by certain comparisons made in more recent years in which highly significant "correlations" seem to have been discovered in places far apart. Thus Darwin in Northern Australia occupies "a position of singular importance in world meteorology" (Quayle). Its air pressure records have proved valuable in forecasting Indian weather and striking correlations seem to appear in the comparison of its weather records with those of many other, chiefly tropical, stations. The Argentine Meteorological Office for a number of years made eight-day forecasts of the weather based in part upon the measurement of the intensity of solar radiation at Calama, Chile, nearly a thousand miles away. A remarkable correlation (coefficient of .88, 1 representing complete proportionality of change) has been discovered between the mean annual level of Lake Nyanza in Africa and sun-spot occurrences.

The discovery of the apparently critical relation of weather conditions at a few given stations to the weather changes at quite distant points adds greatly to the significance of studies in polar meteorology. Unusual localization of meteorological forces has been detected in both the Arctic and the Antarctic. Now it is hardly conceivable that such a habit of localization could continue without correspondingly specific (and in time, we hope, measurable) effects within adjacent areas of wide extent. But the study of localizations is not enough. We have to take account of all the air there is, not of a part of it. There is no reason to suppose that the wide-reaching correlations of lower latitudes may not find their counterpart in high latitudes. Thus the scientist seeks not merely the habit of the weather (or, in more general terms, the characteristics of the climate) of polar regions. He conceives himself as eventually discovering correlations between polar centers of action and those of lower latitudes. Where those key stations may be no one can guess, for the key stations that have been already discovered are far from being explained.

I must at least mention the importance of polar exploration to aviation, especially in view of the service that the airplane has rendered to Arctic and Antarctic expeditions of the past five years. You are familiar with the idea of a trans-Arctic route between Europe and the Far East so long advocated by Stefansson. The idea rests fundamentally upon the stability of meteorological conditions within the Arctic Basin from October to May. No one who has any doubt about that stability could fail to have it dispelled by reading De Long's account of the remarkable uniformity of the weather in the winter that he spent on the *Jeannette* during her drift into the Arctic Sea north of Siberia. But probably long before such flights become practicable we shall have shorter flights from point to point along the fringe of the Arctic. The British Arctic Air Route Expedition is seeking light on controlling local conditions at the present time in Greenland. The "stepping-stone route," as it has been called (Joerg), passes by way of the Faeroes and Iceland to Greenland and Labrador, thus restoring in the air the counterpart of the sea-way that was first pioneered by the Norsemen. We have at last entered the stage forecast by Leonardo da Vinci, who saw no reason why man should not become "lord of the winds and rise conqueror of space."

In so far as sea navigation shall become possible the high latitudes offer many advantages of shortened distances and natural stepping-stones, with man feeling safer, in the present condition of flight technology, in the knowledge that land is beneath him at intervals on the way. In weather forecasting the setting up of

a line of meteorological stations along aviation routes would seem to be a first condition. There must also be a much wider coordination of the observations at stations already established. Finally, both the new and the old stations can not be grouped by countries, as in the past, but must be tied in with the airports at the ends of the routes as well as at points between, wherever they may fall with respect to international boundaries. It thus appears that aviation has its own special requirements. We see that clearly in air pioneering in the United States, where the habit of the weather is fairly well known from region to region. How much more important it becomes in high latitudes of the northern hemisphere where successful flights have already been made by airships and airplane around the earth!

[Following his paper Dr. Bowman showed about sixty slides arranged in eight groups as follows: (1) a map of world rainfall variability in relation to pioneer belts to show the importance to future settlement in relatively high latitudes of strong rainfall variations; (2) the position of high-latitude meteorological stations in the northern hemisphere and the paths of high-latitude low- and high-pressure areas that have weather effects in lower latitudes; (3) types of ice and the conditions of ice discharge in the Arctic and the Antarctic; (4) dynamic conditions in the Arctic and the Antarctic in relation to currents, and land and sea migrations of the present and of past time; (5) economic conditions related to the whaling industry and questions of sovereignty; (6) radio exchanges between New York and the field expeditions of Byrd and Wilkins to illustrate the possibilities of scientific consultation while work is actually in progress; (7) the routes and relations of the four main Antarctic expeditions of the past year; (8) physiographic features, especially in the Antarctic Archipelago.]

OBITUARY

GEORGE FOUCHÉ FREEMAN

1878–1930

DR. GEORGE F. FREEMAN, director of the Federal Experiment Station at Mayaguez, Porto Rico, since April, died suddenly on September 18. Interment was made at Manhattan, Kansas.

Dr. Freeman was born at Maple Grove, Alabama, on November 4, 1876, and was graduated from the Alabama Polytechnic Institute at Auburn, Alabama, in 1903. He was granted the degree of doctor of science by Harvard University in 1917. He began his career as a botanist, but became a plant geneticist and educational administrator. He was a member of the botanical staff of the Massachusetts Agricultural College during 1903, and of the Kansas State Agricultural College from 1904 to 1909. From 1909 to 1918 he was in charge of plant-breeding work at the Arizona Experiment Station. In 1919 he was called to Egypt by the Egyptian government to organize the cotton breeding work for the Sultanic Agricultural Society, where he remained three years, at which time he returned to the United States to accept a similar position with the Texas Agricultural Experiment Station. He remained in Texas for a year and was then appointed to an agricultural commission to Indo China by the French government, which work required a year. Upon his return to the United States he was nominated, by the President of the United States, director general of the Service Technique of Haiti, where he went in 1923 to build up a vocational educational system and an agricultural development program. He remained in Haiti until April, 1930, when he resigned to become director of the Federal Experiment Station at Mayaguez, Porto Rico, at which place he resided until death overtook him.

Dr. Freeman's scientific activities centered primarily around cotton. He gave considerable attention to a study of the various varieties of cotton and had made substantial progress on a monograph of the cottons of the world.

He did his greatest work, however, in Haiti, as an administrator and organizer of the Service Technique. He built up an organization of 476 employees in six years, of which 91.6 per cent. were Haitian, according to the "Annual Report of the Service Technique for 1928–1929."[1] The property valuation, which included school building, school land and school equipment, amounted to $1,475,000. A total of 11,430 pupils and students were being accommodated. While this represents a mere beginning towards reducing the estimated 85 per cent. illiteracy in the country and in building up a nation undeveloped both in agriculture and along industrial lines, it indicates something of the enthusiasm and energy with which this difficult task was undertaken. Dr. Freeman deserves the lasting gratitude of the Haitian people for what he accomplished. The complete realization of the program can not be expected before two or three generations.

Dr. Freeman was the author of numerous reports and scientific contributions. He was a member of sev-

[1] Annual Report, Technical Service of the Department of Agriculture and Professional Education, Port-au-Prince, Haiti, Bul. No. 17. 1929.

eral leading scientific societies and was widely known among scientists and educators.

ROGER C. SMITH
KANSAS STATE AGRICULTURAL COLLEGE,
MANHATTAN, KANSAS

RECENT DEATHS

ERNEST HENRY WILSON, keeper of the Arnold Arboretum of Harvard University, and Mrs. Wilson were killed in a motor accident in Worcester on October 1. Dr. Wilson was fifty-four years old. He had been connected with the arboretum since 1906.

EDWARD FOSTER, state entomologist for Louisiana, died on October 8.

HENRY MARTYN MACKAY, dean of the faculty of applied science and professor of civil engineering at McGill University, died on October 25 in his sixty-third year. He had been associated with the university for twenty-six years and had been head of the faculty of applied science since 1924.

PAUL E. APPELL, professor of mathematics at the University of Paris, member of the Institute of France, died at Paris on October 24. He was seventy-five years old.

SIR FRANCIS WATTS, K.C.M.G., first principal of the Imperial College of Tropical Agriculture at Trinidad, died on September 26, aged seventy years.

LORD BROTHERTON, first baron of Wakefield, has died at the age of seventy-four years. He was the founder of extensive chemical manufacturing plants throughout England and Scotland. In June of this year he was awarded the Messel Medal by the Society of Chemical Industry for his services to the industry.

MEMORIALS

THE Northeastern Section of the American Chemical Society has announced the establishment of a gold medal to commemorate the fundamental contributions made to chemistry by the late Theodore William Richards, who at the time of his death was Erving professor of chemistry at Harvard University and director of the Wolcott Gibbs Memorial Laboratory. The medal, which will be awarded at intervals of two or three years for achievements in chemistry, is being designed by Cyrus E. Dallin, a sculptor who was an intimate friend of Professor Richards. An opportunity is offered the friends of Professor Richards to assist in securing the sum of $10,000 which is required to cover the initial expenses and provide a trust fund yielding sufficient income for the successive medals and incidental expenses.

CONTRIBUTIONS are invited to the Joseph W. Richards fund by the American Electro-chemical Society. The fund was inaugurated by the board of directors, in order that an independent income might be available to be used towards the payment of expenses of invited speakers from Europe or elsewhere. The plan of the fund embodies the wish that the late Professor Richards so often expressed during the many years of his untiring service as secretary of the society. Contributions should be sent to the secretary, Dr. Colin G. Fink, Columbia University, New York City.

THE new observatory on the Rechenberg, near Nüremberg, Germany, has been completed in time for the celebration of the three-hundredth anniversary of the death of Johannes Kepler. In connection with this event there will be an exhibition of objects connected with his life and work.

SCIENTIFIC EVENTS

THE CENTENARY OF THE ROYAL GEOGRAPHICAL SOCIETY

ACCORDING to the London *Times* the Royal Geographical Society celebrated its centenary on October 21 and 22. Since the society was founded 100 years ago under the patronage of King William IV its work has been followed with interest by successive Sovereigns and members of the Royal Family. The Duke of York, representing the King, who is patron of the society, inaugurated the centenary celebrations, and the Prince of Wales, vice-patron of the society, presided at the centenary dinner. The occasion was noteworthy as marking the use, for the first time, of the lecture theater and library, which have been added to the society's house. There were present at the various ceremonies in connection with the centenary representatives of the principal geographical societies throughout the world and delegates from many other scientific institutions.

On the afternoon of October 21, the Duke of York, representing the King, received fellows of the society and delegates from other bodies in the new hall which seats 850 people. The delegates of the Société de Géographie of Paris and of the Gesellschaft für Erdkunde of Berlin—societies which have already celebrated their centenaries—read addresses. The new buildings of the society were then declared open. On Tuesday evening the society held its centenary meeting in the new hall, when Sir Charles Close, the president, Mr. Douglas Freshfield, Sir Francis Younghusband and the Marquess of Zetland, past presidents, and Dr. H. R. Mill, vice-president, spoke on the history of the society.

On October 22 a series of short papers on "The

Habitable Globe" was read at a morning meeting by eminent British and foreign geographers. In the evening the president, council and fellows of the society entertained the delegates and official guests at a reception in the society's house. A further series of papers on "The Habitable Globe" was read on the morning of October 23, and in the afternoon papers on "Incidents in the History of Exploration" were read by Lord Lugard, Sir Francis Younghusband, Sir Halford Mackinder, Lieutenant-Colonel F. M. Bailey, Mr. J. M. Wordie and other British explorers. The centenary dinner of the society was held in the evening at the Connaught Rooms, when the Prince of Wales presided.

The following is a list of foreign geographical societies, in the order of their foundation, which were represented at the centenary celebrations:

Société de Géographie, Paris (1821); Gesellschaft für Erdkunde, Berlin (1828); Verein für Geographie und Statistik, Frankfurt (1836); Instituto Histórico e Geográfico Brasileiro, Rio de Janeiro (1838); Sociedad Mexicana de Geografía y Estadística, Mexico City (1839); Gosudarstvennoe Russkoe Geograficheskoe Obshchestvo, Leningrad (1845); American Geographical Society, New York City (1852); Geographische Gesellschaft, Vienna (1856); Société de Géographie, Geneva (1858); Reale Società Geografica Italiana, Rome (1867); Geographische Gesellschaft, Munich (1869); Magyar Földrajzi Társaság, Budapest (1872); Sociedade de Geografia, Lisbon (1873); Geographische Gesellschaft, Berne (1873); Nederlandsch Aardrijkskundig Genootschap, Amsterdam (1873); Société de Géographie Commerciale, Paris (1873); Geographische Gesellschaft, Hamburg (1873); Societatea Regală Română de Geografie, Bucharest (1875); Real Sociedad Geográfica, Madrid (1876); Société Royale Belge de Géographie, Antwerp (1876); Svenska Sällskapet for Geografiske Selskab, Copenhagen (1876); Société Royale de Géographie, Antwerp (1876); Svenska Sällskapet for Antropologi och Geografi, Stockholm (1877); National Geographic Society, Washington (1888); Sociedad Geográfica, Lima (1888); Norske Geografiske Selskab, Oslo (1889); Sociedad Geográfica, La Paz (1889); Chicago Geographical Society (1894); Association of American Geographers, Nashville (1904); Geografsko Društvo, Belgrade (1910); Sociedad Chilena de Historia y Geografía, Santiago (1911); Polskie Towarzystwo Geograficzne, Warsaw (1917); Association de Géographes Français, Paris (1920); Instituto Coloniale Fascista, Rome (1927), and the Chinese Geographical Society.

THE LANGUAGES OF AMERICAN INDIANS

THE Twenty-fourth International Americanist Congress which met at Hamburg from September 7 to 13 passed the following resolution:

The rapid settlement of America and the progress of assimilation of the natives, as well as the decrease of the population of many tribes bring it about that the languages of the American Indians are rapidly disappearing. On account of their great divergence in structure the Indian languages form one of the most important objects of study for the science of language. Our generation is the last one that is able to collect this material and it is our duty to study the native languages energetically and to preserve these valuable treasures for future times.

Three years ago the Carnegie Corporation, at the instance of the Council of Learned Societies, appropriated funds mainly for the study of North American languages. In some parts of Mexico, Central America and South America the investigations are even more urgently needed than in North America. Notwithstanding the efforts of missionaries many languages are entirely unknown. Of others we have only vocabularies, inadequate grammatical sketches and religious treatises. Modern researches must be based on collections of texts dictated by native speakers, not on translations.

In consideration of these facts the Twenty-fourth International Congress of Americanists meeting at Hamburg has passed the following resolution which is to be transmitted to the Council of Learned Societies:

The Twenty-fourth International Congress of Americanists meeting at Hamburg considers the thorough study of the vanishing native languages of North America, Mexico, Central America and South America one of the most urgent demands of science. The congress expresses its gratitude to the Council of Learned Societies for its active support of these researches and urgently recommends to the council the continuation of its efforts and hopes that it will see to it that the study be extended over the whole continent of America.

Furthermore the congress has passed the following resolution to be transmitted to the Carnegie Corporation: The Twenty-fourth International Congress of Americanists expresses its gratitude to the Carnegie Corporation for their liberal support of inquiries intended to save the vanishing native languages of America. The congress expresses the hope that the undertaking begun with the support of the Carnegie Corporation may lead to a thorough investigation of the languages of the whole American continent.

The congress instructs the delegates of the American governments and institutions to communicate these resolutions to the governments and organizations represented by them.

RECOMMENDATIONS OF THE ADVISORY COMMITTEE ON EDUCATION BY RADIO

THE Advisory Committee on Education by Radio, which was appointed by the Secretary of the Interior, has presented a report signed by William J. Cooper, commissioner of education. The recommendations as contained in the report follow:

1. That there be established in the Office of Education, Department of the Interior, a section devoted to education by radio, and charged with such responsibilities as

the following: (a) To receive from the advisory committee on education by radio its files and collected documents, to keep this material up to date and available for reference by the many students of the subject; (b) to organize some of the material into bulletins to be issued as demand warrants; (c) to outline techniques for research and carry on investigations into the best methods of broadcasting and compare the results of lessons sent to schools by radio with the results obtained by other means; (d) to keep the educational interests of the country fully posted on and alive to the importance of this new instrument as an educational tool; (e) to attempt to prevent conflicts and duplication of effort between various broadcasting interests; (f) to furnish advice on the educational soundness of programs suggested and to supply typical programs upon the request of any station whether educational or commercial.

2. That the funds necessary for financing such a section in the Office of Education be provided in the regular budget for the Department of the Interior.

3. That there be set up in connection with this unit an advisory committee representing educational institutions of commercial broadcasters and the general public. This committee should consist of 9 to 15 persons whose residence is such that they can meet from time to time for actual consideration of problems arising in the Office of Education. This committee may well administer any funds remaining in our budget to promote research into the techniques of radio education.

4. That an effort be made to secure from interested persons or foundations an amount of money sufficient to bring to the microphone, for a period of two to three years, a high grade program in certain formal school subjects and to check carefully the results obtained. The committee believes that as much as $200,000 per year for a period of three years may be wisely expended in this manner, under direction of a non-partisan committee of educators and laymen.

5. That the secretary bring to the attention of the Federal Radio Commission the importance of the educational interests in broadcasting, and that he keep the President of the United States informed of the desirability of having on this commission spokesmen for programs which will tend to improve the general well-being of the American people.

APPROPRIATIONS FOR GRANTS-IN-AID BY THE NATIONAL RESEARCH COUNCIL

AT its meeting in October the National Research Council's Committee on Grants-in-Aid made the following eleven awards:

Arthur A. Bless, associate professor of physics, University of Florida, for a study of diffraction of X-rays by polar molecules subjected to high steady and alternating fields; Perley A. Ross, professor of physics, Stanford University, for study of the width, intensity and structure of the modified line in the Compton effect.

E. M. Kindle, chief, division of paleontology, Geological Survey of Canada, Department of Mines, Ottawa, for a study of criteria for the correlation of Devonian formations; Chester K. Wentworth, associate professor of geology, Washington University, for comparison of glaciated and river-worn cobble stones.

L. R. Cerecedo, assistant professor of biochemistry, University of California at Berkeley, for investigations on the purine fraction of the nucleic acid molecule; Harry J. Deuel, Jr., professor of biochemistry, University of Southern California Medical School, for a study of the relative antiketogenic value of various carbohydrates; Ernest W. Goodpasture, professor of pathology, Vanderbilt University Medical School, for investigations on the etiology of *Granuloma inguinale;* Reginald D. Manwell, assistant professor of zoology, Syracuse University, for a study of avian malaria.

F. E. Chidester, professor of zoology, West Virginia University, for studies on the endocrines of nutrition; James B. Lackey, professor of biology, Southwestern College, for a study of the effects of variation in environmental factors and in cytological technique upon selected types of cells.

Roland C. Travis, associate professor of psychology, Western Reserve University, for investigation of the speed and characteristics of reflex and voluntary eye movements as indicators of the adequacy of adaptive behavior in children and adults.

SCIENTIFIC NOTES AND NEWS

DR. ROBERT GORDON SPROUL was installed as president of the University of California on October 22, filling the vacancy caused by the retirement of Dr. W. W. Campbell. In connection with the ceremonies the doctorate of laws was conferred on Dr. Thomas Hunt Morgan, director of the Kerckhoff Laboratories of the Biological Sciences of the California Institute of Technology, president of the National Academy of Sciences and of the American Association for the Advancement of Science; on Dr. Arnold Bennett Hall, president of the University of Oregon; on Dr. Albert Russell Mann, dean of the College of Agriculture, Cornell University, and on Charles Derleth, Jr., dean of the College of Civil Engineering of the University of California.

THE John Fritz gold medal, regarded as the highest honor of the engineering profession in America, has been awarded for 1931 to Rear Admiral David Watson Taylor, retired, "for outstanding achievement in marine architecture, for revolutionary results of persistent research in hull design, for improvement in many types of warships and for distinguished service

as chief constructor of the United States Navy during the world war." The award was made unanimously by the John Fritz Medal Board of Award, composed of four representatives each of the four American societies of civil, mining and metallurgical, mechanical and electrical engineers. Recent recipients of the medal include Ralph Modjeski, Herbert Hoover, John J. Carty, Elmer A. Sperry, Edward Dean Adams, John F. Stevens and Ambrose Swasey.

DR. WALTER B. CANNON, George Higginson professor of physiology at the Harvard Medical School, has been elected a foreign honorary fellow of the Royal Society of Edinburgh.

DR. MAX HARTMANN, professor of protozoology at Berlin, and Dr. Eduard Reichenow, professor of protozoology at Hamburg, have been awarded the Fritz Schaudinn Medals.

THE address at the opening session of the School of Pharmacy of the Pharmaceutical Society of Great Britain was delivered on October 1 by Dr. Arthur W. Hill, director of the Royal Botanic Gardens, Kew. The Pereira Medal of the society was presented to him on this occasion.

SIR JOHN RUSSELL, director of Rothamsted Experimental Station, England, has been elected president of the International Congress of Soils. The next congress will meet at Cambridge, England, in 1935, at which time it is proposed to follow the plenary sessions with a soils tour of the Mediterranean countries, including Spain, Algiers, Egypt, Palestine, Greece, Italy and France.

AT the recent meeting of the American Ornithological Union held at Salem, Massachusetts, the following officers were elected: Dr. Joseph Grinnell, University of California, president; A. C. Bebt, Taunton, Massachusetts, and J. H. Fleming, Toronto, vice-presidents; Dr. T. S. Palmer, Washington, D. C., secretary; W. L. McAtee, Washington, D. C., treasurer; James P. Chapin, New York City; Ruthven Deane, Chicago; Harry C. Oberholser, Washington, D. C.; James L. Peters, Cambridge, Massachusetts; Charles W. Richmond, Washington, D. C.; Thomas S. Roberts, Minneapolis, and Percy A. Taverner, Ottawa, members of the council.

AT the annual meeting of the Board of Directors of the Boyce Thompson Institute for Plant Research held at Yonkers, New York, on October 15, Mrs. William Boyce Thompson was unanimously elected chairman of the board to fill the vacancy left by Colonel Thompson's death last July. During his life Colonel Thompson had endowed the institute to the extent of ten million dollars, and had large plans for the further extension of its usefulness, which Mrs. Thompson takes a keen interest in furthering. The other members of the board are: Charles F. Ayer, Raymond F. Bacon, William Crocker, Caleb C. Dula, Frederick H. Ecker, Robert A. Harper, Lewis R. Jones, Thomas Lamont, Fred J. Pope and Margaret Thompson Schulze.

MR. DONALD BISHOP PRENTICE, dean of the department of engineering at Lafayette College, has been elected president of the Rose Polytechnic Institute at Terre Haute, Indiana.

DR. L. R. JONES, of the University of Wisconsin, who has been in charge of plant pathology since the organization of this work, retired in June as chairman of the department, but will continue his other duties on a part-time basis. Dr. G. W. Keitt has been appointed chairman.

DR. F. L. PICKETT, head of the college department of botany of Washington State College, has been appointed dean of the graduate school.

DR. JOSEPH O. CRIDER, dean and professor of physiology and histology at the University of Mississippi School of Medicine, has resigned to become associate professor of physiology and assistant dean in the Jefferson Medical College, Philadelphia. Dr. Crider has been succeeded at the University of Mississippi by Dr. Philip L. Mull, professor of anatomy at the school.

DR. JAMES A. DOULL recently resigned his position as coordinator of the study of common cold which is being conducted at the Johns Hopkins University School of Hygiene and Public Health, to become professor of hygiene and public health at Western Reserve University Medical School. Dr. Doull had been granted a leave of absence as professor of epidemiology at Johns Hopkins to carry on this work.

DR. LEROY C. ABBOTT, chief surgeon at Shriners Hospital for Crippled Children, St. Louis, has become head of the department of orthopedics at Stanford University.

DR. ADDISON GULICK, who has been teaching at the University of Missouri since 1912, since 1921 as professor of physiological chemistry, has been appointed head of the department of biological chemistry.

WE learn from the *Experiment Station Record* that Dr. J. J. Willaman, chief in research in chemistry at the Agricultural Experiment Station at Geneva, New York, has tendered his resignation to enter commercial work. Dr. W. H. Rankin, associate in research (plant pathology) has been granted six months' sabbatic leave to carry on special studies at Cornell University. Dr. P. J. Chapman, entomologist at the Virginia Truck Station, has been appointed chief in

research in entomology. He will direct the new entomological investigations on the apple maggot in the Hudson Valley. Other appointments include George W. Pearce, as assistant in research in entomology, for chemical investigations with insecticides, and H. L. Durham as dairy technologist.

DR. X. HENRY GOODENOUGH, chief engineer of the Division of Sanitary Engineering, Massachusetts, has retired, and Dr. Arthur D. Weston has been appointed his successor.

DR. S. HERBERT ANDERSON has resigned from the department of physics, University of Washington, to accept the position of physicist in charge of the Signal Corps Laboratories, Fort Monmouth, New Jersey. For the past two years Dr. Anderson has been on leave from the University of Washington at the request of the Daniel Guggenheim Fund for the Promotion of Aeronautics, to investigate the problems of fog flying, at the Wright Field.

DR. L. I. SHAW has been advanced to the rank of assistant superintendent of manufacturing development in charge of chemical photographic laboratories, cable development application, raw materials and ceramic development of the Western Electric Company, Chicago.

MR. NEIL M. JUDD has been put in charge of the new division of archeology of the U. S. National Museum, as curator. It is made up of the former divisions of American archeology and old world archeology.

DR. HENRY ARNSTEIN, who is acting in advisory capacity to the Governments of Argentina, Brazil, Cuba and Colombia, has sailed for South America to deliver a series of lectures on the utilization of natural resources, the elimination of waste and recovery of by-products. Dr. Arnstein expects to return to the United States in January.

LEAVE of absence has been given by the University of California to Associate Professor R. W. Hodgson to enable him to accept an invitation by the Government of France to visit Tunisia and Morocco and report on the horticultural possibilities of these districts.

DR. M. L. NICHOLS, assistant professor of analytical chemistry at Cornell University, has returned to Ithaca after a year's study at the Universities of Leipzig, Graz and Rostock, as a fellow of the Guggenheim Foundation.

DR. GEORGE R. JOHNSTONE is on sabbatical leave for the first semester of the present academic year from the department of botany of the University of Southern California at Los Angeles. Professor A. C. Life, of the same department, will be on sabbatical leave the second half of the year. His work will take him abroad and he will return to the university in the autumn of 1931. Dr. H. de Forest is again chairman of the department, following the custom of a revolving chairmanship.

DR. H. H. MANN, assistant director of the Woburn sub-station of the Rothamsted Experimental Station, is shortly leaving England for south Russia, to advise as to the possibility of the extension of the tea-growing industry. Before joining the Rothamsted staff, Dr. Mann was engaged in tea research in India.

ON October 23 at Boston the Forsythe Lecture was delivered by Dr. Henry C. Sherman, Mitchill professor of chemistry at Columbia University, on "The Significance of the Protective Foods."

THE Cutter Lecture on Preventive Medicine of the Harvard Medical School was delivered on October 28 by Professor M. W. Weinburg, of the Pasteur Institute, Paris, on "Anaerobic Infections and their Serotherapy."

DR. ARCHIBALD V. HILL, Foulerton research professor of the Royal Society, lectured on "The State of Water in Tissues" at Northwestern University Medical School on October 20.

AT the meeting of German scientific men and physicians held at Königsberg from October 7 to 10 the principal addresses were made by Dr. David Hilbert, professor of mathematics at Göttingen, and Dr. F. Paneth, professor of chemistry at Königsberg. Dr. Hilbert's address was entitled "Naturkenntnis und Logik." Dr. Paneth's address was a memorial to Lothar Meyer.

THE International Institute of Agriculture, which owes its existence to the Californian economist, David Lubin, celebrated the twenty-fifth anniversary of its foundation on October 14 in Rome in the presence of the King of Italy, its founder and patron; representatives of the seventy-four states adhering to the institute, and all the highest Italian officials. Premier Mussolini made the principal speech, which was answered by M. Zameta, president of the Council of the League of Nations; M. Vassileff, the Bulgarian Minister of Agriculture; M. Poczinsky, Minister from Poland; Marcel Heraud, under-secretary of the Presidency of France; Sir Daniel Hall, first delegate of Great Britain, and Senator Demuchelis, president of the Institute of Agriculture.

ACCORDING to an announcement sent by the secretary, Professor Charles P. Berkey, Columbia University, the forty-third annual meeting of the Geological

Society of America will be held Monday, Tuesday and Wednesday, December 29 to 31, 1930, under the auspices of the University of Toronto. The scientific sessions will be held in the Mining and Physics Buildings. The address of the retiring president, Dr. R. A. F. Penrose, Jr., will be delivered Monday evening at the Royal York Hotel, on "Geology as an Agent in Human Welfare," followed by a complimentary smoker. The annual dinner of the society will be held on Tuesday evening. Accommodations are available in the residences of the University of Toronto and meals may be obtained at Hart House. All sessions are open to the general public, but the council requests each fellow to send to the secretary as soon as practicable, and not later than December 15, the names and addresses of advanced students or other persons who are seriously interested in geology and are deserving of recognition as visitors. The council will then invite them to attend the meeting. Visiting ladies should register as arrangements are being made for local entertainment. In conjunction with the society the Paleontological Society will hold its twenty-second annual meeting and the Mineralogical Society of America its eleventh annual meeting. The Society of Economic Geologists will also hold meetings under the same auspices. Section E of the American Association for the Advancement of Science will hold meetings in Cleveland, Ohio, Wednesday, Thursday and Friday, December 31 to January 2. A joint session with the Geological Society of America is being arranged for January 1.

THE second annual Conference of Donors of the Johns Hopkins National Fellowship Plan will be held at the university on November 7. After the speech of welcome by President Joseph S. Ames, the conditions of the annual renewal of fellowships will be discussed under the leadership of Mr. C. G. Campbell, president of the Kewaunee Manufacturing Company, and of Mr. H. A. B. Dunning, president of Hynson, Westcott and Dunning. In the afternoon the selection, education and testing of students who possess creative ability will be considered under the leadership of Mr. Martin Matheson, director, John Wiley and Sons, Incorporated; Professor J. C. W. Frazer, chairman of the Johns Hopkins University department of chemistry; F. O. Clements, director of research, General Motors Corporation, and Dr. A. A. Backhaus, vice-president of the U. S. Industrial Alcohol Company. There will be a luncheon for donors, faculty and fellowship students and a dinner to the donors in the evening. An after-dinner address will be made by Dr. Arthur D. Little, on "Leadership," and a sound picture on "Cosmic Rays," by Dr. Robert A. Millikan, of the California Institute of Technology, will be presented.

UNDER the auspices of the Iowa chapter of Sigma Xi, with Professor G. W. Stewart, national president of the society, presiding, a symposium on the navigation and flood control problems of the Mississippi River was recently presented by A. C. Trowbridge, professor of geology at the University of Iowa; F. A. Nagler, professor of hydraulic engineering, and S. M. Woodward, head of the department of hydraulics.

THE United States Civil Service Commission states that the position of senior toxicologist, Bureau of Chemistry and Soils, Department of Agriculture, is vacant, and that the following method of competition will be used to fill the vacancy. Instead of the usual form of civil-service examination, the qualifications of candidates will be passed upon by a special board of examiners, composed of W. W. Skinner, assistant chief, Chemical and Technological Research, Bureau of Chemistry and Soils; M. X. Sullivan, biochemist, Hygienic Laboratory, and A. S. Ernest, examiner of the United States Civil Service Commission. The entrance salary for this position in Washington is $4,600 a year; if appointment is made to the Field Service the entrance salary may be at any rate within the salary range of $4,600 to $5,400 a year, varying with conditions obtaining at the headquarters where the vacancy exists. For the following-named open competitive examinations applications should be received before November 19: senior technologist (cellulose) with salary range from $4,600 to $5,400 a year; technologist (foods) and technologist (textiles) from $3,800 to $4,600 a year. Applications for geologist for reservoir and dam site investigations must be on file not later than November 26, 1930. The entrance salary is $3,800 a year. This examination is to fill vacancies in the Bureau of Reclamation, Department of the Interior, for duty in Washington, D. C., Denver, Colo., and elsewhere in the field. Competitors will be rated on their education, training and experience, and on writings.

THE Alpha Chi Sigma dinner at the fall meeting of the American Chemical Society was attended by one hundred and twenty members of the fraternity. H. E. Wiedemann, consulting chemist, St. Louis, and a national vice-president of the organization, served as toastmaster. Among the speakers were the national president, Charles A. Mann, head of the department of chemical engineering, University of Minnesota; M. C. Jewett, Procter and Gamble Co., and secretary of the Cincinnati professional chapter; Harry A. Curtis, National Research Council and fraternity historian; Gunnar Carlson, president of Alpha Delta, the local chapter at the University of Cincinnati; E. F. Farnau, professor of chemistry, University of Cincinnati; H. B. Stevenson, Procter and Gamble Co., and associate

editor of *The Hexagon* of Alpha Chi Sigma, and Dr. E. K. Rideal, of Oxford University.

A MEETING of the American Section of the Société de Chimie Industrielle was held at Chandler Lecture Hall, Columbia University, on October 24, 1930. Mr. Arthur H. Sleigh, who as a boy had met Michael Faraday and whose father was intimately acquainted with him, gave his personal recollections—incidentally bringing out the fact that Faraday was greatly interested in botany. Mr. Sleigh exhibited Atkin's book on the flora of Great Britain, published in 1823, which his father and Faraday had jointly used in identifying the plants they found. Dr. René J. Dubos, of the Rockefeller Institute for Medical Research, then addressed the meeting on "Enzymes from Microorganisms and their Application to Industrial and Medical Problems."

A LABORATORY for the study of fresh-water animals of the United States is being installed at the University of Missouri at Columbia under supervision of Dr. Max M. Ellis, director of interior fisheries investigations for the United States Bureau of Fisheries and professor of physiology in the University of Missouri. Its completion within the next few weeks will provide a central point for the observation of chemical and physiological phenomena of fresh-water animals, to which various fresh-water problems of the Bureau of Fisheries will be referred. In order to provide adequate space for carrying on necessary experimental work, the University of Missouri has turned over a section of one of the medical buildings to the work. Funds for the installation of the laboratory were subscribed conjointly by the university and the Bureau of Fisheries.

DISCUSSION

GIBBS'S PHENOMENON

IN May 30, 1930, issue of SCIENCE there appeared a communication from Professor Tomlinson Fort, objecting to the use of the term "Gibbs's phenomenon" for series other than Fourier's series. As the only name which he cites in this connection is my own, readers may possibly infer that I am responsible for this extended use of the term. As this is quite contrary to the fact, I feel that I should make some comment on the point that Professor Fort has raised.

The various developments in orthogonal functions, such as Laplace's functions, Legendre's functions and Bessel's functions, which occur in mathematical physics, present so many analogies to the better-known Fourier's series that it is quite natural and logical to use for the former series an identical terminology in the case of similar properties. So far as Gibbs's phenomenon is concerned this was done as early as 1910 by Weyl[1] in two papers dealing with the behavior of developments in Laplace's functions, Legendre's functions and Sturm-Liouville functions. The extended meaning of the term in the case of Bessel's functions was used by at least one writer[2] prior to my own use of it. The terminology to which Professor Fort objects is therefore not a recent innovation, as his communication may suggest, but a well-established usage on the part of investigators in this field.

Aside from this point, however, I can not agree with several of Professor Fort's contentions. In the first place, the phenomenon in the case of Fourier's series was not first noticed by Gibbs, as he states. It is now well known that it had been pointed out some fifty years earlier by Wilbraham.[3] In the second place, while I entirely agree with Professor Fort as to the fundamental importance of Osgood's classical papers on the general theory of non-uniform convergence, I can not admit that they treat the same point as that involved in Gibbs's phenomenon. In Osgood's discussion the peaks of non-uniform convergence only occur in cases where the limit function is continuous. The examples which he gives of non-uniformly convergent series with discontinuous sum exhibit no peaks. One of the most essential characteristics of Gibbs's phenomenon is the appearance of peaks in the neighborhood of a point of discontinuity of the function developed. I think that it would be quite appropriate to use the term "Osgood's phenomenon" in the case where the limit function is continuous, but not in the situation where the term "Gibbs's phenomenon" has been generally used.

CHARLES N. MOORE
UNIVERSITY OF CINCINNATI

[1] *Rendiconti del Circolo Matematico di Palermo*, 29 (1910): 308; 30 (1910): 377.

[2] *Cf.* R. G. Cooke, *Proc. London Math. Soc.*, 27 (1928): 171.

[3] *Cf.* historical notes by H. S. Carslaw and C. N. Moore, *Bull. Amer. Math. Soc.*, 31 (1925): 420, 417.

THE PRESENT STATUS OF LACTENIN

MENTION was made in an earlier number of this journal of our work on a bacteriostatic substance in milk. To avoid misunderstanding it seems well to summarize the properties and discuss the possible uses in so far as the present status of the problem permits.

It has been known for some time that milk which had not been heated above 60° C. will inhibit the growth of certain bacteria. We have studied the effect of this material on the mastitis streptococcus. It prevents growth for about six hours, after which

growth suddenly begins and continues at a rapid rate. This growth was shown to result from an adaptation of the streptococcus without using up the bacteriostatic substance. We give the name lactenin to this substance. In sufficient concentration it will completely prevent the multiplication of certain bacteria, such as the scarlet fever streptococcus, so that they finally die.

Lactenin preparations contain protein and it may itself be a protein. It is difficult to separate from the other proteins of whey, although the casein can be readily separated from milk leaving whey with the full activity of the original milk. This difficulty is met by digesting the other proteins with trypsin. Mild digestion does not injure the lactenin. The products of digestion can be removed by dialysis, or the lactenin can be precipitated with alcohol.

Owing partly to its combination with calcium phosphate, the lactenin-containing material in concentrated form is quite insoluble and forms at best a poor suspension. It is possible to remove the calcium phosphate, giving a more soluble material, but the conditions must be carefully regulated to prevent inactivation of the lactenin.

Dried lactenin preparations are 200 to 500 times as active as dried skimmed milk. The method used to determine lactenic activity is to measure the size of colonies of scarlet fever streptococcus growing in a thin layer of veal infusion agar jelly to which horse blood is added. The more lactenin present the smaller the colonies will be. One gram of dried material in 100 gallons of this media will produce perceptible inhibition, whereas one gram in 10 gallons will completely prevent the growth of these bacteria.

Either the dried material or neutral suspension of it will keep for months in the refrigerator without loss in activity. It is probably not a pure substance. It contains protein, but no reducing sugar or elements aside from carbon, hydrogen, oxygen and nitrogen. It exists as a salt of whatever cation may be present, particularly calcium, and appears to have a low isoelectric point.

Lactenin, while very active against some microorganisms, is less active against others.

We make no claims that lactenin is a preservative of the milk or that it could be used for a food preservative. Our investigations have not been concerned with this phase of the question.

It is not known whether lactenin inhibits the growth of mastitis streptococci in the udder, although this appears plausible.

We do not know whether the lactenin in milk has any effect on intestinal infections in animals which drink the milk. It is likely that the stomach acidity would destroy the lactenin.

Since suggestions have been made that lactenin might have a therapeutic value, we would caution against too much hope in this regard until experimental data can be obtained. Satisfactory injections have not been possible up to the present owing to the insolubility of the preparations and the physical properties of the suspensions.

F. S. JONES
H. S. SIMMS

DEPARTMENT OF ANIMAL PATHOLOGY,
THE ROCKEFELLER INSTITUTE,
PRINCETON, NEW JERSEY

AN ACCESSIBLE TROPICAL VEGETATION

IN his description of our collection from Barro Colorado Island Dr. Paul C. Standley[1] states that Mr. Salvoza and I must have visited the island at a particularly favorable time. While that may have been the case still I think the splendid success we had in finding plants new to that region was largely due to the fact that most of our collecting was done along the shore-line with the help of a cayuga (dug-out canoe), which was provided by the laboratory.

The difficulties of collecting in a tropical jungle have long been recognized and with good reason. The very tall trees are much interlaced with vines, and flowers or fruits are almost always inaccessible. When fallen specimens are available it is difficult to know certainly whether they are from one of the tall trees or from a vine which the tree supports.

Barro Colorado Island was cut off from the mainland when the valley surrounding it was flooded to a depth of eighty-five feet to form Gatun Lake and the channel of the Panama Canal.

Since the inundation was of very recent date, no littoral or shore-line vegetation has been formed and the mid-forest types which are almost inaccessible in the interior of the jungle very often overhang the shore with flowers and fruit being borne on the lower branches.

The many long, branched inlets allow a large part of the island to be explored from the shore.

Barro Colorado Island does have on it a most unusual collection of native Central American plants, and without doubt many of them are yet not listed as being present there.

The added feature of the accessibility of the flora makes it unique among tropical floras and speaks well for the foresight of the founders of the Institute of Tropical Research which is situated there.

WALTER N. BANGHAM
GOODYEAR PLANTATIONS COMPANY,
SUMATRA

[1] Paul C. Standley, *Jour. Arnold Arboretum*, April, 1930.

THE PRONUNCIATION OF "CENTIMETER"

AT a recent meeting of the American Institute of Electrical Engineers in New York frequent use was made, necessarily, of the word "centimeter." Sometimes it was given a thoroughly Anglicized pronunciation and occasionally an equally good French pronunciation, but several times during the day one would hear a rather unpleasant variation, an unsuccessful attempt being made to pronounce the first syllable as in French while the last was given a distinctly English sound. Since the nasal sound and slight lisp and burr are difficult to the average American, why not adopt the Anglicized pronunciation as the standard for English speech?

EVAN THOMAS
UNIVERSITY OF VERMONT

DISCOVERER OF THE CALCULUS

THE correspondent in your current issue (SCIENCE, August 15, 1930)—Professor G. A. Miller—says on page 168 that English and German writers have long been claiming for their respective countries the honor of having discovered the calculus. Your readers will find in the forthcoming number of *Science Progress* for October a full article by J. M. Child, showing that the calculus was discovered by Newton's teacher, Professor Isaac Barrow, of Cambridge, before 1670. All that Newton added was the algebraic statement of the calculus, while Leibnitz suggested only the algorism now in use. Mr. Child has long been studying the matter and has given it close attention. So far as I can see his contention is perfectly sound, and I think that it was Barrow who invented the calculus. Important works are so apt to be lost sight of in the rush of publications that I think your readers will thank me for calling attention to the matter.

RONALD ROSS
Editor of Science Progress

SPECIAL CORRESPONDENCE

WORK IN PARASITOLOGY AT THE UNIVERSITY OF MICHIGAN BIOLOGICAL STATION

A CENTER for teaching and research in the field of parasitology has been developed in the last few years at the University of Michigan Biological Station on Douglas Lake, Michigan. Researches in this subject at the Douglas Lake station date back to the first collections of parasites made from this region in 1912. During the next five years researches on the life cycles of the digenetic trematodes were carried on by several visiting investigators. Beginning with the session of the summer of 1917, when the directorship of the station was taken over by Dr. George R. LaRue, a regular program of investigations on parasitic worms, chiefly on the trematodes, has been carried out by the director and his students aided from time to time by visiting investigators. In 1927 a regular course was first given at the Michigan Biological Station in the field of parasitology by Dr. W. W. Cort, of the Johns Hopkins University, and Dr. L. J. Thomas, of the University of Illinois. The presence at the station of three men interested in parasitology and representing three different institutions has made it possible each summer to gather together a considerable group of graduate students and visiting investigators in this subject.

The course as at present outlined covers only the field of helminthology. It is limited to graduate students and seniors who have completed sixteen hours of zoology. The lectures are devoted chiefly to the biology of the parasitic worms, but include also reviews of the more important helminths of man and domesticated animals. In the laboratory periods special emphasis is given to the study of living material illustrating all the stages in the life histories of the different groups of parasitic worms. The class makes a number of host examinations and learns the methods of preserving and mounting. In the summer of 1930 each student made for himself a set of about a hundred slides representing all the groups of the parasitic worms, mounted according to a variety of technique methods. In 1929 eleven students were registered in this course and in 1930 the number was nine.

Researches in parasitology at the Biological Station are carried on by the members of the staff, visiting investigators and graduate students. In the summer of 1930 the total group carrying on investigations of some kind or another in this field amounted to sixteen individuals. The subjects that were covered by this group were quite varied. The largest number investigating any one phase of the subject were working on the life cycles of the digenetic trematodes, including studies on the further development of holostome, schistosome and stylet cercariae. Another group was studying the life cycles of tetraphyllidean and proteocephalid cestodes. The other researches on the helminths were concerned with cestode and nematode morphology and with the life cycles of several nematodes in aquatic hosts. The protozoa of the region have been hardly touched. One interesting research on the blood-inhabiting protozoa was carried out during the summer of 1930. Life history studies seem to be best suited to the location and equipment of the Biological Station. The life cycles of a considerable number of parasitic worms have already been worked

out and others are in the process of solution. Facilities are available for the keeping of experimental animals, including an aquarium building and houses for mammals, birds and reptiles. The location of the laboratories in the midst of the lake region of northern Michigan makes available a wealth of problems on the parasites of aquatic animals. A permanent collection of the parasites of the region is being built up which is becoming of increasing value in the researches.

The summer of 1930 saw the moving of the University of Michigan Biological Station into enlarged quarters. Two laboratories are entirely given up to the work in parasitology, and plans are under way to increase considerably the facilities for handling experimental animals for the life history studies and for other types of experimental work. The work is well past the preliminary stages and every indication points to increased development of personnel and facilities. Interest in parasitology has greatly increased in the United States in the last decade, and the development of this center at the Michigan Biological Station will help to meet the demand for summer work in the biological phases of this subject.

W. W. CORT

SCHOOL OF HYGIENE AND PUBLIC HEALTH,
JOHNS HOPKINS UNIVERSITY

BOTANICAL LEGACIES OF WALTER DEANE

BY bequest of the late Walter Deane, who died at his home in Cambridge, Mass., July 30, 1930, in his eighty-third year, there have been received by the Gray Herbarium of Harvard University: (1) His herbarium, consisting of about 40,000 sheets, selected and mounted with special care, representing chiefly the flowering plants, ferns and fern-allies of the region covered by Gray's Manual; (2) his botanical library, including about 500 volumes; (3) his collection of portraits of botanists.

Mr. Deane, for many years widely known as an enthusiastic amateur botanist with extensive correspondence and wide-reaching exchange relations, was a member of the visiting committee of the Gray Herbarium since 1897, and one of the founders of the New England Botanical Club, being at different times its phanerogamic curator, its vice-president, from 1908 to 1911 its president and for some years its librarian. His botanical specimens were left to the Gray Herbarium with the provision that the New England Botanical Club be allowed to take from them such as might be useful in supplementing its own collections.

Mr. Deane's herbarium has long been noted among American amateur collections of its kind. In it there are many series to illustrate the development of the seedling from earliest germination to normal adult foliage. Particular care was also taken to illustrate the ripe fruit and mature seed, as well as to supply pocket material for dissection. Finally, unusual attention was devoted to the effective exhibition of the roots and other subterranean parts so far as possible.

The collection is historically important since a large part of its specimens have been from time to time studied by specialists and monographers such as Gray, Watson, Bebb, Morong, Davenport and many others, so that the value of the specimens has been greatly increased by critical notes of such authorities recorded during monographic work.

In addition to the valuable botanical collections here described, Mr. Deane bequeathed to the Gray Herbarium the sum of $20,000, the income thereof to be expended in the care of its library, and a further legacy of $25,000 to be paid to Harvard University at the expiration of certain life interests and to be used for the general purposes of the Gray Herbarium. He also left the sum of $1,000 to the New England Botanical Club for the promotion and care of its herbarium.

The passing of Mr. Deane removes from American botany a notable figure. His modesty and enthusiasm as well as his exceptional powers of friendly and helpful interest in the work of others won for him the affectionate regard of all who came into touch with his scientific pursuits.

B. L. ROBINSON

SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN IMPROVED SOIL SAMPLER

SOIL samplers of various designs have been employed for many years. The most common tool used in the classification of soil types is the screw type soil auger. A sharp spade and the post-hole digger are likewise frequently employed in securing soil samples. The major disadvantages of these three tools lie in the necessity of handling the sample and in the disturbed condition of the soil. Perhaps the spade and the post-hole digger are not as unsatisfactory as is the screw type auger, but they are awkward to manipulate.

For use on any soil free from gravel or rocks the writer has devised a tool which enables one to obtain a sample in the form of a cylinder of any desired length. This instrument has proved particularly useful in obtaining undisturbed soil samples in nearly natural condition.

The tool is made in one piece. It consists of a heavy galvanized iron pipe 36 inches long and 1¼

inches in diameter, with a one-inch galvanized pipe, 18 inches long, brazed to the top to form a T handle.

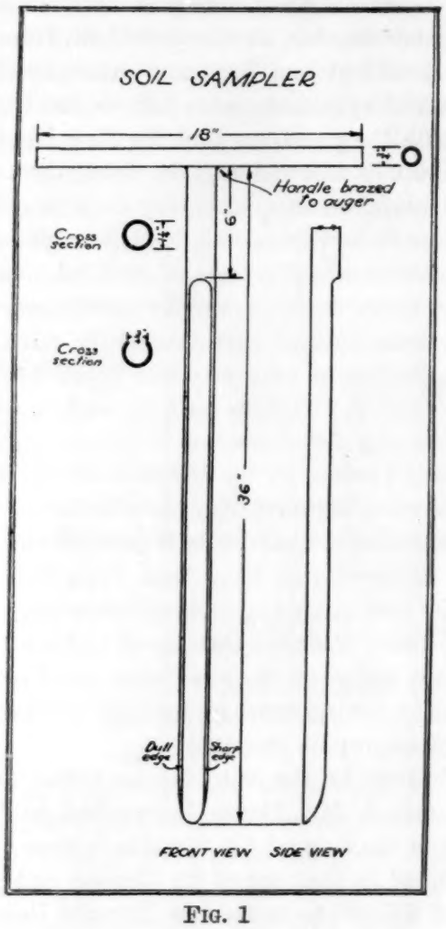

FIG. 1

A ¾-inch slit is cut in the main pipe, from the bottom to a point six inches below the handle. The right edge of this slit, as viewed from the handle, is dull; the left edge is beveled from within, making a cutting edge 30 inches in length. The lower end of the tool is finished in a rounded point, sharpened at the end.

In operation the tool is simultaneously thrust into the ground and turned gradually to the right in the same manner as an ordinary screw type soil auger. After the tool has entered the soil to the desired depth a slight backward twist releases the core from the main body of the soil. The tool is then slowly pulled out, with particular care to avoid sudden jerks. When the tool is taken from the soil it carries a cylindrical core of slightly compacted soil. A pocket knife is inserted into the soil core at the point where the cylinder begins to taper. This piece of core is pushed out in order to permit the easy removal of the main core from the cylinder. The core can be gradually pushed out in sections, by means of a knife blade or other flat instrument. The emerging core is cylindrical, and it will be found that the interior physical structure has been but slightly affected. The writer has used such a soil sampler at different times and under diverse conditions, always obtaining better results than with the screw-type auger.

L. J. PESSIN
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SPECIAL ARTICLES

ADRENAL CORTEX EXTRACT AND CANCER[1]

THE treatment of cancer by glandular extracts has had a moderate study limited by the few glandular extracts existing in pure form. The most recent and highly vaunted treatment has been that of Coffey and Humber,[2] of San Francisco, who used what was said to be an adrenal cortex extract of unstated composition. The curative claims made for their method are so great as to make further study of these extracts of importance in order to establish the place of cortical extracts in the treatment of cancer patients.

A modified adrenal cortex preparation has been described and discussed by Sokoloff.[3] The preparation of Auler and others[4] is unfortunately rather toxic. Kondo[5] was unable to discover any definite evidence that extracts of the suprarenal cortex act as stabilizers of growth in young mammals. The outcome obtained by Joannovics,[6] Pearce and Van Allen,[7] Auler[8] and Floercken[9] is of academic interest only, as removing or destroying the adrenal glands in an effort to elicit a restraining influence on transplanted tumors is an indirect method of approach, after all. Still less direct is the method of Flaks,[10] who mixed the tumor graft with adrenal tissue and found an inhibitory effect when the mixture was tested by injecting into normal animals.

In all these experiments no statement is made as to the efficiency of the adrenal cortex extract in substituting for the glandular hormone itself in adrenalectomized animals. Such an efficient extract has been prepared and described by Swingle and Pfiffner[11] and

[1] From the Cancer Research Laboratories, Graduate School of Medicine, University of Pennsylvania.

[2] W. B. Coffey and J. D. Humber, *J. A. M. A.*, 94: 359, 1930.

[3] B. Sokoloff, *J. A. M. A.*, 94: 652, 1930.

[4] H. Auler, H. Schlottmann, W. Rubenow, P. Meyer and B. Wolff, *Zeits. f. Krebsforsch.*, 32: 195, 1930.

[5] T. Kondo, *Archiv. f. Jap. Chir.*, 6: 62, 1929.

[6] G. Joannovics, *Beitr. z. pathol. Anat.*, etc., 62: 194, 1926.

[7] L. Pearce and C. M. Van Allen, *Trans. Assoc. Amer. Phys.*, 38: 315, 1923.

[8] H. Auler, *Zeits. f. Krebsforsch.*, 22: 210, 1925.

[9] H. Floercken, *Zeits. f. Krebsforsch.*, 24: 465, 1927.

[10] J. Flaks, *Zeits. f. Krebsforsch.*, 30: 145, 1929.

[11] W. W. Swingle and J. J. Pfiffner, SCIENCE, 71: 321 and 489, 1930.

named by them the *cortical hormone*. The method of preparation of this cortical hormone has been fully given, so that there is no secret about it. The extract has been shown to be effective in substituting for the cortical hormone in adrenalectomized cats and is therefore an effective extract. Previously described extracts have not been proved to be effective in preventing symptoms in adrenalectomized animals.

So with an adrenal cortex extract of proved efficiency, experiments were made upon cancer animals. Those chosen were mice with spontaneously developing carcinoma of the breast of a long-established stock. These mice have cancer occurring spontaneously in approximately 20 per cent. of the females. The disease progresses to a fatal result with a known duration and such spontaneous cancers are not subject to the remissions and disappearance of the tumor as are the transplanted, grafted or induced cancers in rats and other animals. In addition, the character of the tumor and its course are more like human breast tumors.

The adrenal cortical extract or cortical hormone was prepared for us by Swingle and Pfiffner[12] and was periodically obtained fresh from their laboratory. There was, therefore, the association of a freshly prepared cortical extract of known and not secret composition and a definite cancer tumor of known character and one which is not subject to remissions.

The subcutaneous dose suggested by Drs. Swingle and Pfiffner was 0.03 cc. This amount, for a mouse weighing 30 gm, would be equivalent to 60 cc in a 60 kgm man. Assuming a life-span for the mouse of 3 years, and for man one of 60 years, 3 months' observation on the mouse would correspond to 5 years on man.

The material was first tested on normal animals, daily injections being given to new-born and premature mice. They did not show any ill effects and developed well, as did their controls, even when the dose was greatly increased. In other words, no stabilization of growth could be demonstrated.

Injections of the same material given to the tumor mice were without any appreciable effect on spontaneous neoplasms of this species; these grew steadily, taking their usual course quite uninfluenced by the treatment. Even when a large dose was given this was also the case. Not a single tumor in two dozen mice was arrested clinically, the results having thus been entirely negative. Death occurred at the customary times in all the animals, and the injections were without effect.

[12] The laboratory wishes to express here sincere thanks to Drs. W. W. Swingle and J. J. Pfiffner, of Princeton University, for their courtesy and their generous gift.

As spontaneous growths of the mouse are analogous with those of man,[13, 14, 15] it is very probable that the treatment here described would be useless in the human patient. The charting of the tumors was done by measurement weekly, and inspection of these shows a continuous and progressive growth in spite of injection of adrenal cortex extract of known efficiency in substitution for the cortical hormone in adrenalectomized animals.[16]

CONCLUSIONS

Spontaneous breast carcinoma in the mouse was treated by the adrenal cortex extract of Swingle and Pfiffner without any curative or restraining effect upon the tumors. No therapeutic value in the treatment of such animal cancers was shown in the cortical hormone, although the efficacy of this preparation in substituting for the adrenal cortex hormone in adrenalectomized animals has been thoroughly proved. The use of such adrenal cortex extract in human patients is not therefore to be recommended as a treatment of cancer but this in no way detracts from the value of this adrenal cortex extract of Swingle and Pfiffner in other conditions than cancer, as it has been proved to be effective as a substitute for the cortical hormone.

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THE LIFE CYCLE OF THE PARASITE OF EAST COAST FEVER IN TICKS TRANSMITTING THE DISEASE. (PRELIMINARY NOTE)

EAST COAST fever is a disease of cattle of considerable economic importance which is found on the eastern half of the African continent from the Sudan to the Cape of Good Hope. The causative agent *Theileria parva* is one of a large group of parasites which inhabit red blood cells and are called piroplasms. Perhaps the widest known among the group is *Babesia bigemina,* the organism causing Texas cattle fever, which holds the distinction of being the first parasite definitely proved to be insect (*i.e.,* arachnid) transmitted (Smith and Kilborne, 1893). Despite this early epoch-making discovery the actual life cycle of not a single piroplasm has been completely worked out in the tissues of the transmitting ticks, though many attempts have been made.

The following is a preliminary report of some results secured in an experimental study of the parasite of East Coast fever in ticks (*Rhipicephalus*

[13] F. C. Wood, *J. A. M. A.*, 66: 94, 1916.
[14] W. H. Woglom, *Jour. Cancer Res.*, 7: 379, 1922.
[15] S. Itami, *J. A. M. A.*, 72: 934, 1919.
[16] Illustrations showing the growth will be included in a reprint which will be sent to scientific men who may be interested.

appendiculatus) undertaken at the invitation of the colonial secretary, Lord Passfield, acting for the Government of Kenya, and on the recommendation of Sir Arnold Theiler. The experiments were conducted in the Government Laboratories at Kabete near Nairobi. To both the director of agriculture, the Honorable Alexander Holm, and the chief of the Veterinary Research Laboratory, Mr. James Walker, we wish to express our thanks for many courtesies. We are grateful also to Mr. R. Daubney, who was acting chief of the laboratory during a part of our stay in Kabete; to Dr. E. A. Lewis and to Mr. W. B. C. Danks, both of whom helped us in the actual conduct of our experiments.

The observations were made on six principal series of ticks: (1) Infected as larvae; (2) control, fed on a clean animal as larvae; (3, 4 and 5) infected as nymphae; (6) control, fed on a clean animal as nymphae. They were complicated and difficult for three reasons. First, because in some cases only a relatively small percentage of ticks fed on blood containing parasites retain them throughout their life cycle. Second, the uniform presence of symbionts was a confusing factor in the study of smears soon after engorgement. Lastly, the large majority of the ticks, both infective and clean, contained a protozoan parasite, different from that of East Coast fever, with multiplicative phases in the macrophages in the tick's body and to a lesser extent within the intestinal epithelial cells. All the animals used for the feeding of ticks were carefully reared and free from other tick-borne diseases.

We have found that the life cycle of *Theileria parva* in ticks is divisible into the following stages:

(1) Emigration of parasites from the red blood cells into the gut of the tick begins soon, but parasites may remain in the red blood cells for as long as six days after the ticks drop off engorged.

(2) In the lumen of the gut what appear to be male and female forms are distinguishable, and further examination of the material collected may show that it is here that conjugation takes place.

(3) Many of the free forms in the gut are destroyed *in situ;* others are taken up by the intestinal epithelial cells and digested within them in association with digestive spherules; still others penetrate intestinal epithelial cells, which are not provided with digestive spherules, and grow.

(4) These intra-epithelial parasites make their appearance about the sixth day. From the sixth to the twenty-third day their diameter increases approximately five times. They are recognizable up to the thirty-first day, that is to say over the period of moulting which was accomplished in the several infected series on the twenty-fourth, twenty-fourth, twenty-fourth and eighteenth days after engorgement.

(5) From the day before moulting through the actual moulting and as late as the thirty-first day these intra-epithelial forms change into motile euglena-like forms. These euglenoids penetrate the wall of the intestine and enter the body cavity. They make their way to the salivary glands, where they may be seen in contact with the cells. They were last detected in the four series on the thirty-third, thirty-fourth, thirty-fifth and twenty-ninth days, respectively.

(6) Over a period of several days after their formation the euglenoids enter the salivary gland cells. Their entry was not observed in the larval series, but in the three series of nymphae they were seen as early as the twenty-fifth, twenty-third and twenty-second days.

(7) Once within the salivary gland cells the euglenoids rapidly change into deeply staining spore-like structures, which increase in size to form mulberry-like masses. The peripheral swellings on the mulberries give rise to small forms of the parasite which resemble closely those first observed in sick animals. This is the condition of the parasite usually seen in the salivary glands at the time that the next feeding began on the thirty-third, thirty-sixth, thirty-fifth and twenty-ninth days after engorgement.

(8) During the first four days of feeding the small forms increase greatly in number at the expense of the mulberry-like masses. Many of them are discharged into the lumina of the salivary acini, but some were still seen in ticks as late as the twelfth day after attachment.

The bites of ticks belonging to the series containing these parasites in their salivary glands produced East Coast fever in susceptible animals, whereas those of the control, clean ticks which did not possess parasites failed to do so.

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